

**Berryessa Creek Project
Santa Clara County, California**

**Appendix C
Economics**



FEBRUARY 2013

BERRYESSA CREEK PROJECT APPENDIX C, ECONOMICS

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION	1-1
1.1 Purpose and Scope	1-1
1.2 Study Area	1-1
1.3 History of Flooding	1-1
1.4 Consistency with Regulations and Policies	1-1
1.5 Price Levels, Period of Analysis, and Discount Rate	1-1
CHAPTER 2: FLOODPLAIN AREA AND INVENTORY	2-1
2.1 Economic Data Area	2-1
2.2 Inventory of Structures and Property in Study Area	2-4
2.3 Value of Damageable Property - Structure Value	2-5
2.4 Value of Damageable Property- Content Value	2-7
CHAPTER 3: METHODOLOGIES, DEPTH-DAMAGE RELATIONSHIPS AND FLOODING CHARACTERISTICS	3-1
3.1 Economic HEC-FDA Model and Application of Floodplain Data	3-1
3.2 Computation of Stage-Damage Curves within the HEC-FDA Model	3-1
3.3 Depth-Damage Relationships	3-2
CHAPTER 4: DAMAGES BY EVENT	4-1
4.1 Damage Estimation	4-1
4.2 Economic Uncertainty Parameters	4-1
4.3 Other Damage Categories	4-2
4.4 Stage-Damage Functions	4-3
CHAPTER 5: FUTURE ECONOMIC DEVELOPMENT	5-1
5.1 Midtown Redevelopment	5-1
5.2 Vacant Acres and Proposed Land Use	5-1
5.3 Inundation Damages – 100-year Event	5-1
CHAPTER 6: EXPECTED ANNUAL DAMAGES – WITHOUT-PROJECT CONDITIONS	6-1
6.1 HEC-FDA Model	6-1
6.2 Estimation of Expected Annual Damages	6-1
6.3 EAD Future Conditions	6-3
6.4 Project Performance- Without Project Conditions	6-4
CHAPTER 7: WITH-PROJECT CONDITIONS – FLOOD RISK MANAGEMENT BENEFITS	7-1
7.1 Project Benefits – The Role of Economics in the Plan Formulation Process	7-1
7.2 With Project Conditions - Model Simulations	7-1
7.3 Average Annual Equivalent Damages –With Project Conditions	7-2
7.4 Alternatives Evaluated – Flood Risk Management Benefits	7-2
7.5 Probability Distribution – Damages Reduced	7-3
7.6 Project Performance – With Project Conditions	7-5
7.7 Other Benefits	7-8
CHAPTER 8: BENEFIT COST ANALYSIS – NED PLAN IDENTIFICATION	8-1

8.1	Annual Costs.....	8-1
8.2	Net Annual Benefits.....	8-2

LIST OF TABLES

Table 2.1	Structural Inventory	2-5
Table 2.2	Valuation Example.....	2-6
Table 2.3	Content to Structure Ratios	2-7
Table 2.4	Value of Damageable Property	2-8
Table 3.1	Depth Damage Curves	3-3
Table 4.1	Stage-Damage Functions Impact Area A	4-4
Table 4.2	Stage-Damage Functions Impact Area B.....	4-4
Table 4.3	Stage-Damage Functions Impact Area C.....	4-5
Table 4.4	Stage-Damage Functions Impact Area D	4-5
Table 4.5	Stage-Damage Functions Impact Area E.....	4-6
Table 4.6	Stage-Damage Functions Impact Area F.....	4-6
Table 6.1	Without-Project Probability Damage – HEC-FDA Model	6-2
Table 6.2	Expected Annual Damages Existing Without-Project Conditions	6-3
Table 6.3	Average Annual Equivalent Damages Future-Without Project Conditions	6-4
Table 6.4	Project Performance – Without-Project Conditions	6-5
Table 7.1	Annual Benefits by Alternative	7-3
Table 7.2	Equivalent Annual Damages Reduced Upstream.....	7-4
Table 7.3	Equivalent Annual Damage Reduced Downstream.....	7-4
Table 7.4	Project Performance Impact Area A.....	7-6
Table 7.5	Project Performance Impact Area B.....	7-6
Table 7.6	Project Performance Impact Area C.....	7-6
Table 7.7	Project Performance Impact Area D.....	7-7
Table 7.8	Project Performance Impact Area E	7-7
Table 7.9	Project Performance Impact Area F	7-7
Table 7.10	Advance Bridge Replacement Benefits.....	7-9
Table 8.1	Summary of Construction Cost by Alternative.....	8-2
Table 8.2	Equivalent Annual Damage Reduced	8-2
Table 8.3	Annual Benefits and Costs by Alternative.....	8-3

LIST OF FIGURES

Figure 2.1	Economic Impact Areas	2-2
Figure 2.2	Study Reach and Impact Area Locations.....	2-3
Figure 6.1	Uncertainty in Discharge, Stage and Damage in Determination of Expected Annual Damages.....	6-2

CHAPTER 1: INTRODUCTION

1.1 Purpose and Scope

The purpose of this report is to present the results of the economic analysis performed for the General Reevaluation study of the Berryessa Creek Project. The report documents the reevaluation of benefits and costs of the authorized project in comparison with potential changes in design, benefits, and costs for a modified project and alternative plans. This information is necessary to determine the extent of Federal interest in a modified or new plan for flood damage reduction along Berryessa Creek. The report presents findings related to flood risk, potential flood damages and potential flood risk management benefits.

1.2 Study Area

The study area is located in Santa Clara County California. Berryessa Creek runs through the cities of Milpitas and San Jose, an urbanized alluvial plain that includes a diverse mix of residential, commercial, industrial, and public land uses. The population of Milpitas and San Jose are 67,476 and 958,789 respectively (source: California Department of Finance, E-1 May 2011.) The area is part of California's Silicon Valley, with many computer, bio-tech and hi-tech firms located in the area.

1.3 History of Flooding

Recent flood events from Berryessa Creek include those in March 1982, January 1983 and February 1998. It was reported that the 1998 event caused minor damages to homes and automobiles but dollar losses were not documented. No non-residential structure losses were reported from these events. Specific frequency was not identified for floods within the study area but each noted event was believed to be smaller than the 0.10 exceedance probability event.

1.4 Consistency with Regulations and Policies

This economic analysis is in accordance with standards, procedures, and guidance of the U.S. Army Corps of Engineers. The Planning Guidance Notebook (ER 1105-2-100, April 2000) serves as the primary source for evaluation methods of flood risk management studies and was used as reference for this analysis. Additional guidance for risk-based analysis was obtained from EM 1110-2-1619, *Engineering and Design – Risk-Based Analysis for Flood Damage Reduction Studies* (August 1996) and ER 1105-2-101, *Planning - Risk Analysis for Flood Damage Reduction Studies* (January 2006).

1.5 Price Levels, Period of Analysis, and Discount Rate

Unless otherwise noted, all values in this document are presented in October 2011 prices, and amortization calculations are based on the Fiscal Year 2013 federal discount rate of 3.75

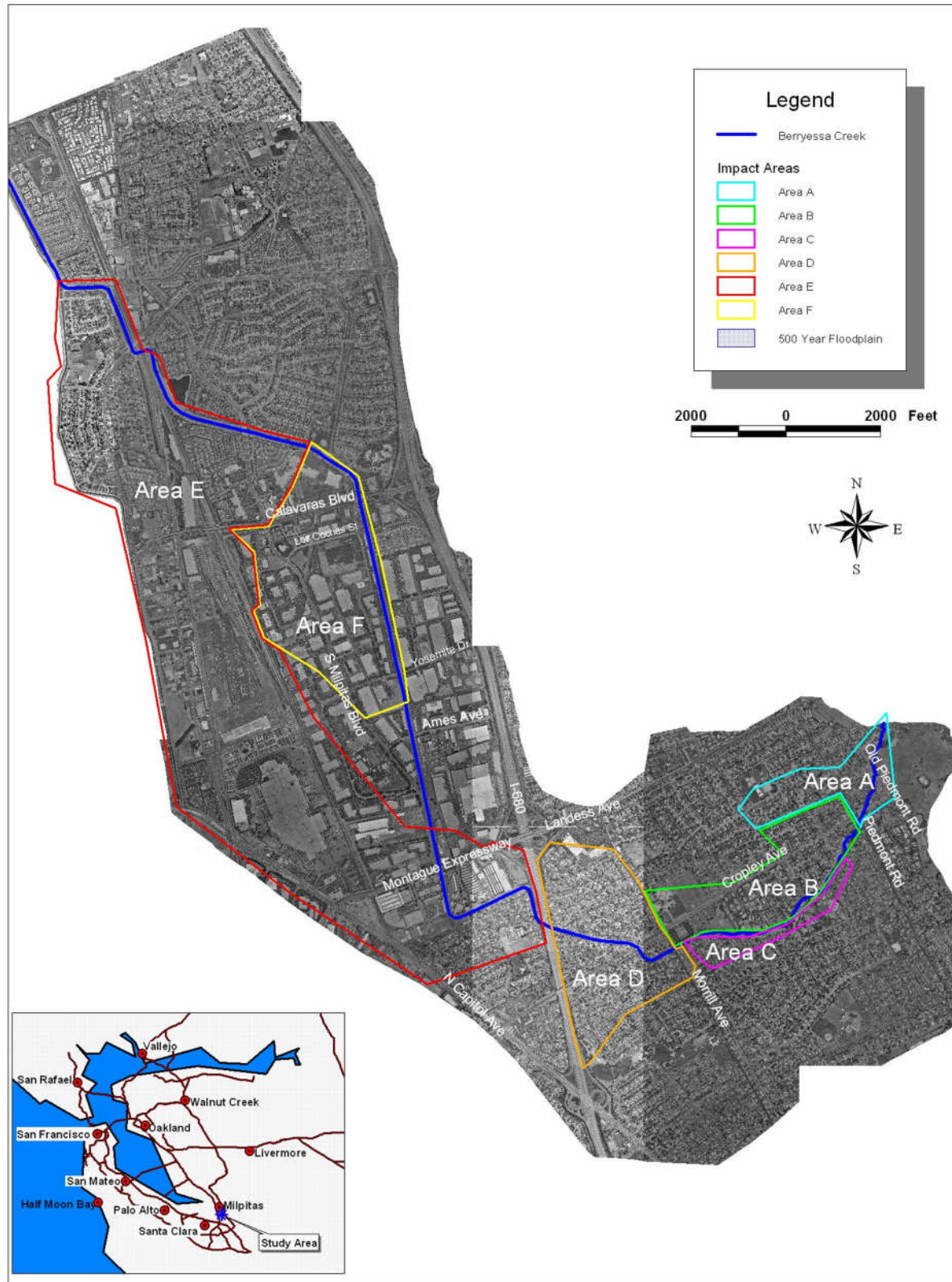
percent as published in Corps of Engineers Economic Guidance Memorandum 13-01. Economic evaluation was performed over a 50-year period of analysis with a base year of 2017.

CHAPTER 2: FLOODPLAIN AREA AND INVENTORY

2.1 Economic Data Area

The study area was divided into six economic impact areas for economic evaluation and project performance purposes. Delineations were made to address changes in hydrology, hydraulics and economic conditions throughout the creek. A map showing the six impact areas is shown in Figure 2.1. A comparison of the impact areas to the linear study reaches is provided in Figure 2.2.

- Area A lies farthest east and runs from Old Piedmont to the intersection of Cropley Avenue and Piedmont Road. The area consists of single family residences.
- Area B includes Cropley Avenue and runs along the right bank from Piedmont to Morrill Avenue. The area is primarily residential.
- Area C runs along the left bank just past Majestic Elementary and Berryessa Creek Park downstream just east of Morrill. The area is primarily residential.
- Area D runs from Morrill to the I-680 Freeway. This area in San Jose is primarily residential.
- Area E is the largest impact area in the study and begins just west of I-680. The area is bounded by Capitol Avenue, Abel Street and Berryessa Creek. This area includes the Midtown region of Milpitas and includes residential, commercial, public and industrial land uses.
- Area F runs along a short section of the left bank of Berryessa from Yosemite Drive to near Los Coches Street and east of WP railroad line. This impact area is highly industrial with many hi-tech firms in addition to some commercial and limited residential.

**Figure 2.1 Economic Impact Areas**

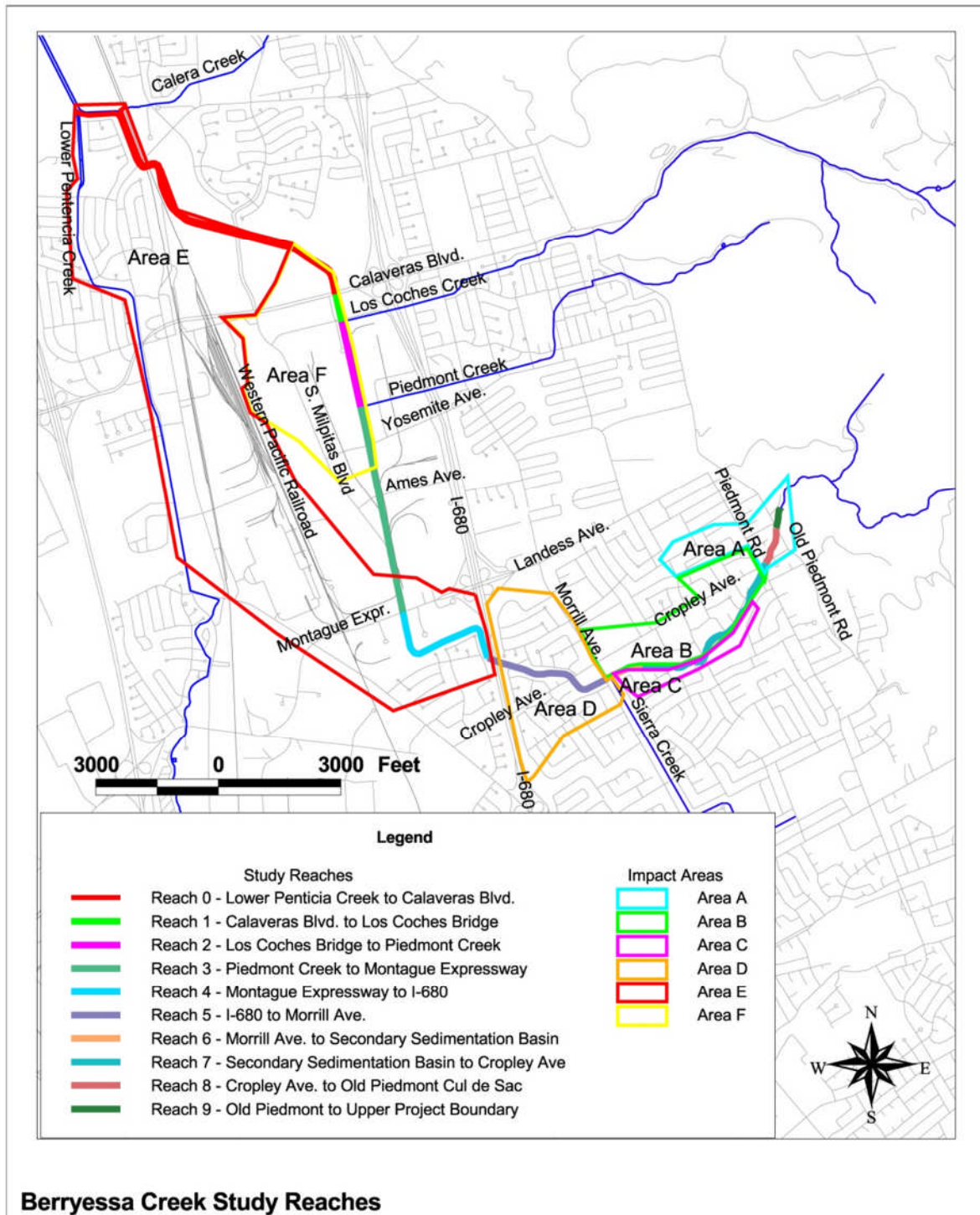


Figure 2.2 Study Reach and Impact Area Locations

2.2 Inventory of Structures and Property in Study Area

A structural inventory was previously completed based on data gathered from assessor's parcel data and on-site inspection of all the structures (100%) within the floodplain. Structures were determined to be within the economic study area by using Geographical Information Systems (GIS) to compare the 0.002 exceedance probability floodplain boundary with the spatially referenced assessor parcel numbers (APN). The inventory was developed in accordance with Section 308 of WRDA 1990.¹ Information from the assessor's parcel database (such as land use, building square footage, address) was supplemented during field visitation for each parcel within the floodplain to collect additional required data such as, foundation height, specific business activity (non-residential), building condition, type of construction, number of units. Parcels with structures were categorized by land use and grouped into the following structural damage categories:

- 1) **Single Family Residential** – includes all parcels represented by a single unit such as detached single family homes, individually owned condominiums and townhouses.
- 2) **Multiple Family Residential** – includes residential parcels with more than one unit such as apartment complexes, duplexes and quadplex units. Each parcel may have multiple structures.
- 3) **Commercial** – includes retail, office buildings, restaurants
- 4) **Industrial** – includes warehouses, light and heavy manufacturing facilities. Also includes many computer and bio-tech industries that are in the Milpitas area.
- 5) **Public** – includes both public and semi-public uses such as post offices, fire stations, government buildings, schools and churches.

All parcels with structures were assigned to one of the listed categories. Some parcels have more than one physical structure and some structures, such as condominiums, are represented by multiple parcels. Table 2.1 displays the total number of parcels (number of units for multifamily residential) with structures by category.

¹ Section 308 instructs the analysis to not include any new or substantially improved structure (other than a structure necessary for conducting a water-dependent activity) built in the 100-year flood plain with a first floor elevation less than the 100 -year flood elevation after July 1, 1991

Table 2.1 Structural Inventory

Number of Parcels With Structures within the 0.002 Exceedance Probability Floodplain By Land Use							
Economic Impact Area	Single Family Residential	Multiple Family Residential Units	Commercial	Industrial		Public	Total
				General	Tech		
Area-A	64	0	0	0	0	0	64
Area-B	96	287	0	0	0	1	384
Area-C	14	0	0	0	0	0	14
Area-D	378	105	0	0	0	0	483
Area-E	723	1,110	95	22	17	15	1,982
Area-F	1	0	14	8	25	4	52
Total	1,276	1,502	109	30	42	20	2,979
Number of Parcels With Structures within the 0.010 Exceedance Probability Floodplain By Land Use							
Area-A	35	0	0	0	0	0	35
Area-B	77	257	0	0	0	1	335
Area-C	12	0	0	0	0	0	12
Area-D	231	26	0	0	0	0	257
Area-E	589	1,050	82	22	16	13	1,772
Area-F	1	0	14	8	25	4	52
Total	945	1,333	96	30	41	18	2,463

In total there are 1,000 more units at risk than shown in the 1987 Feasibility report. The biggest difference is multi-family residences that have increased in the area.

2.3 Value of Damageable Property - Structure Value

The value of property at risk was estimated based on depreciated replacement values (DRV). Structure value was determined based on the following function:

$$\text{DRV} = \text{Square Footage} * \text{Cost per Square Foot} * \text{Depreciation Factor}$$

Evaluations of Corps flood risk management projects require structures be valued using replacement costs minus depreciation. These values may differ from assessed values, sales or market values, reproduction costs or values determined by income capitalization. Depreciated replacement cost does not include land values and market prices (which include land value) or sale price for homes and commercial property would be higher than the value of the depreciated structure alone.

Building characteristics such as quality type, condition, and number of stories were gathered for each parcel. Square footage representing the building area was taken from assessor's parcel data for each structure. Values for cost per square foot were determined based on land use, building type, construction class and quality.

Values were taken from the Marshall and Swift (M&S) Valuation Service and were adjusted using the M&S local multipliers for San Jose to account for the higher construction costs found in the Milpitas/San Jose area. Factors such as the year the structure was built, overall condition of the building, improvements, required maintenance and comparative data from other studies were used in determining the subjective measure of how much depreciation to assign each structure.

In the database, each structure was assigned a mean remaining value percentage (100% replacement minus estimated percent depreciated) to be used in determining depreciated replacement value. The range of depreciation varied with each structure and land use with new structures assigned zero depreciation and a maximum of 60% for a few structures in poor condition.

Uncertainty in remaining percent value was determined to be a triangular distribution with minimum and maximums set at plus or minus 10% not to exceed 100% total value. Examples of a typical structure valuation by damage category using median values found in this study are shown in Table 2.2. These values are displayed to explain the methodology used but do not represent any particular structure or mean values within the study.

Table 2.2 Valuation Example

Depreciated Replacement Value, October 2011 Prices Using Typical Structures by Category					
Structure Category	Square Footage	Price Per Square Foot (locally adjusted)	Estimated Depreciation Percentage	Remaining Value Percentage	Depreciated Replacement Value of Typical Structure
	Using Median Values By Category				
Single Family Residential	1,480	\$144.08	15%	85%	181,247
Multiple Family Residential Units	1,900	\$96.41	30%	70%	128,219
Commercial	4,680	\$144.74	15%	85%	575,759
Industrial	11,870	\$147.49	15%	85%	1,488,051
Public	10,000	\$182.52	10%	90%	1,642,674

2.4 Value of Damageable Property- Content Value

In addition to structures, building contents can also be at risk of flood damages. For this study, content values were estimated as a percentage of depreciated structure value based on land use. During the 1992 General Design Memorandum (GDM) on Berryessa Creek, detailed content surveys were made to determine content percentages specific to the Milpitas/San Jose area. For this reevaluation study, no additional content surveys were completed to confirm or adjust values used in the original study.

The 1992 GDM survey requested identification of business activity, square footage or known value of the building, total value of content or ratio content to structure value if known. The survey also asked respondents to provide estimated loss of contents for various theoretical floods. As no known flood events have occurred in the study area resulting in non-residential damage, responses were limited to best guess estimates. Based on these survey results, the 1992 GDM content percentages were considered to be reasonable. Minor adjustments were made to the industrial category (sub-divided for content analysis only in this study as Industrial-General and Industrial-Tech) to represent the recent surveys. The industrial-tech content category includes computer component manufacture and distribution, and biotechnology commonly found in the San Jose/Milpitas area. Both content values and percent losses were greater for the industrial-tech than typical industrial activities, which is why industrial content losses were separated for this analysis. The sub-categories for commercial business only differ in the assigned content percentages (does not affect structure depth-damage functions). Content percentages by sub-category are given in Table 2.3.

Table 2.3 Content to Structure Ratios

Structure Sub-Category	Content Percent of Structure Value
Commercial-Food	130 %
Commercial-Office	50 %
Commercial-Retail	100 %
Commercial-Restaurants	75 %
Commercial- Department Stores	150 %
Industrial-General	131 %
Industrial- Tech	187 %
Public	45 %
Residential	50 %

Total value of damageable property is comprised of the structural and content values described for the parcels within the 0.002 exceedance probability floodplain. Table 2.4 shows the total structure and content values by category and economic impact area. In total, the study area has just under \$2.3 billion worth of estimated damageable property. Total value of over \$1 billion for structures within the floodplain is over eight times the value found in the 1987 Feasibility study. Factors leading to these increases include: additional structures, general increases in valuation from 1986 to 2011, improvements in existing structures and increased labor and construction costs in the area.

Table 2.4 Value of Damageable Property

Within the 0.002 Exceedance Probability Floodplain Values in \$ Millions, October 2011 Prices							
Structure Category	Area-A	Area-B	Area-C	Area-D	Area-E	Area-F	Total
SFR-Structure	11.7	17.6	2.4	63.3	123.3	0.4	218.7
SFR-Content	5.8	8.8	1.2	31.7	61.7	0.2	109.4
MFR-Structure	0.0	27.3	0.0	11.4	224.6	0.0	263.3
MFR-Content	0.0	13.6	0.0	5.7	112.3	0.0	131.6
Commercial-Structure	0.0	0.0	0.0	0.0	227.6	30.6	258.2
Commercial-Content	0.0	0.0	0.0	0.0	246.0	29.1	275.1
Industrial-General Structure	0.0	0.0	0.0	0.0	74.1	30.9	105.0
Industrial-Tech Structure	0.0	0.0	0.0	0.0	82.5	161.0	243.5
Industrial- General Content	0.0	0.0	0.0	0.0	97.1	40.4	137.5
Industrial-Tech Content	0.0	0.0	0.0	0.0	154.3	301.1	455.4
Public- Structure	0.0	8.3	0.0	0.0	30.3	14.2	52.8
Public- Content	0.0	3.7	0.0	0.0	13.6	6.4	23.7
Total Value	17.5	79.3	3.6	112.1	1,447.4	614.3	2,274.2

CHAPTER 3: METHODOLOGIES, DEPTH-DAMAGE RELATIONSHIPS AND FLOODING CHARACTERISTICS

3.1 Economic HEC-FDA Model and Application of Floodplain Data

The Hydrologic Engineering Center's HEC-FDA model (version 1.2.4, FRM-PCX certified model) was used to perform the economic damage and benefits analyses. More detailed descriptions about the capabilities of HEC-FDA model and how it was used are provided in the following paragraphs.

The HEC-FDA model was used to integrate the engineering data (hydrologic, hydraulic, and geotechnical), compute stage-damage curves using specially-formatted output data, and compute initial AEP and EAD results under without-project and with-project conditions.

For structure and content damages, depth of flooding relative to the structure's first floor is the primary factor in determining the magnitude of damage. Unlike previous economic analyses for the study area that employed Excel spreadsheets to determine inundation damages, the current analysis utilizes HEC-FDA's internal processes for the determination of structural inundation. The current HEC-FDA process combines a GIS database containing spatially referenced polygons for each parcel in the study area with water surface elevations developed in Flo2D for each structure.

A ground elevation was assigned to the centroid of each parcel using GIS for the study. Foundation heights, determined during field visitation, were added to the assigned ground elevation to establish first floor elevations. Water surface elevations (WSE) from the Flo2D model were provided in the form of grid cells for the 0.500, 0.200, 0.100, 0.040, 0.020, 0.010, 0.005, and 0.002 exceedance probability events. Parcels were then correlated with the grid cell in which the centroid laid. Flooding depths in general were rather shallow with very few structures facing depths greater than 3 feet and an average of one foot above ground elevation for the largest event.

3.2 Computation of Stage-Damage Curves within the HEC-FDA Model

For the suite of floodplains, WSE floodplain data was formatted so that the floodplains could be directly imported into the HEC-FDA model as a water surface profile. The formatted files contained every grid cell that contained a structure and the water surface elevations in each grid cell for each frequency event. The suite of floodplains along with the imported structure inventory was used in HEC-FDA to compute stage-damage curves.

Instead of using river station numbers, assignment of water surface elevations by frequency event were completed using grid cell numbers; the grid cell assignments represent actual floodplain water surface elevations by frequency event rather than in-channel water surface elevations. Once the formatted floodplain data were imported into HEC-FDA, a row was inserted at the top of the WSP which included the in-channel stages associated with the index

point (for a particular impact area). This step allowed for the linkage between the 2-dimensional floodplain data and the in-channel stages. Importing formatted floodplain data and assigning water surface elevations to grid cells eliminated the need for creating interior-exterior relationships, which is another way to link exterior (river) stages to interior (floodplain) stages within HEC-FDA.

3.3 Depth-Damage Relationships

Damages to structures and contents were determined based on depth of flooding relative to the structure's first floor elevation. To compute these damages, depth damage curves were developed. These curves assign loss as a percentage of value for each parcel. The deeper the relative depth, the greater the percentage of value damaged. The sources of the relationships were different depending on land use. For single family residential structures and contents, depth damage curves were taken from Economic Guidance Memorandum EGM 01-03, *Generic Depth Damage Relationships*. For the other (non-single family residential) structure categories, the damage curves were based on 1998 FEMA Flood Insurance Administration data with the exception of the industrial content curves. For industrial content, the depth damage curves used in the original Corps study were modified based on the current survey responses (see Section 2.4). The resultant depth damage curves are shown in Table 3.1 by category.

Table 3.1 Depth Damage Curves

Damage Category	Depth of Flooding – Above First Floor in Feet						
	-1	0	1	2	3	4	5
Percent Damage of Structure Value							
Commercial 1-Story	0 %	7.0 %	16.3 %	24.7 %	27.7 %	29.6 %	30.9 %
Commercial 2-Story	0 %	5.0 %	9.9 %	13.4 %	18.0 %	20.0 %	22.0 %
Industrial Gen 1-Story	0 %	7.0 %	16.0 %	25.0 %	28.0 %	30.0 %	31.0 %
Industrial Gen 2-Story	0 %	5.0 %	10.0 %	13.0 %	18.0 %	20.0 %	22.0 %
Industrial Tech 1-Story	0 %	7.0 %	16.0 %	25.0 %	28.0 %	30.0 %	31.0 %
Industrial Tech 2-Story	0 %	5.0 %	10.0 %	13.0 %	18.0 %	20.0 %	22.0 %
Public 1-Story	0 %	7.0 %	16.3 %	24.7 %	27.7 %	29.6 %	30.9 %
Public 2-Story	0 %	5.0 %	9.9 %	13.4 %	18.0 %	20.0 %	22.0 %
Residential 1-Story SF	0 %	13.4 %	23.3 %	32.1 %	40.1 %	47.1 %	53.2 %
Residential 2-story SF	0 %	9.3 %	15.2 %	20.9 %	26.3 %	31.4 %	36.2 %
Residential 2-Story Apt	0 %	9.3 %	15.2 %	20.9 %	26.3 %	31.4 %	36.2 %
Percent Damage of Content Value							
Commercial 1-Story	0 %	0 %	22.8 %	49.5 %	64.7 %	91.2 %	100.0 %
Commercial 2-Story	0 %	0 %	19.1 %	31.4 %	35.6 %	45.1 %	50.0 %
Industrial Gen 1-Story	0 %	0 %	35.2 %	64.2 %	74.8 %	91.8 %	96.3 %
Industrial Gen 2-Story	0 %	0 %	29.6 %	40.8 %	41.2 %	45.9 %	48.1 %
Industrial Tech 1-Story	0 %	0 %	35.2 %	64.2 %	74.8 %	91.8 %	96.3 %
Industrial Tech 2-Story	0 %	0 %	29.6 %	40.8 %	41.2 %	45.9 %	48.1 %
Public 1-Story	0 %	0 %	22.8 %	49.5 %	64.7 %	90.2 %	100.0 %
Public 2-Story	0 %	0 %	19.1 %	31.4 %	35.6 %	45.1 %	50.0 %
Residential ¹ 1-Story SF	0 %	16.2 %	26.6 %	35.8 %	44.0 %	51.4 %	57.6 %
Residential ¹ 2-story SF	0 %	10.0 %	17.4 %	24.4 %	31.0 %	37.0 %	42.6 %
Residential 2-Story Apt	0 %	5.0 %	8.7 %	12.2 %	15.5 %	18.5 %	21.3 %

¹ The EGM 01-03 curves estimate content damages as a direct function of structure value. The percentages listed in this table assume content value at 50% of structure value and percentages have been modified accordingly.

CHAPTER 4: DAMAGES BY EVENT

4.1 Damage Estimation

As previously referenced, damages were estimated within HEC-FDA employing its full function of relating structure inventory data with water surface elevations by exceedance probability events. Structure values for insertion into HEC-FDA, as mentioned in Section 2.3, were determined as a function of Marshall Valuation Service values per square foot, square footage and estimated depreciation. Structure valuations for HEC-FDA input were based on triangular distribution of Marshall Valuation factors for each structure by type of construction.

4.2 Economic Uncertainty Parameters

Many of the factors that determine flood damages can be represented by a range of values instead of a single number. Errors in measurement, variation in classification and judgment can lead to differences in values. For this study, in accordance with EM 1110-2-1619, uncertainties in the following parameters were considered in the HEC-FDA damage estimation:

- Structure Value
- Content-to-Structure Value Ratio
- First Floor Elevation
- Depth-Damage Percentage

In 2006 for the feasibility study, to estimate the uncertainty in structure valuation, triangular distributions for each of these parameters were set in the model. For a hypothetical example, a house of good construction may have a value of \$115 per square foot, average construction \$85 per square foot and very good \$140 per square foot. The range in parameters, value per square foot for each land use type, along with range of $\pm 10\%$ of measured square footage and $\pm 10\%$ estimated depreciation were used in the Monte Carlo simulation to determine both the coefficient of variation (standard deviation divided by the mean) and distribution of structure valuation. For all land uses, the Monte Carlo simulation was evaluated in @RISK BEST FIT which indicated a normal distribution provided the best fit with the following coefficients of variation:

- Single Family Residential = 12 %
- Multi-Family Residential = 14 %
- Commercial = 12 %
- Industrial = 16 %
- Public = 16 %.

Content damages were estimated as a percentage of structure value. For residential contents, these percentages were taken as direct function of structure value and determination of content ratio was not required (see EGM 01-03). For industrial content percentages, the

uncertainties were taken from the survey results with a logistic distribution providing the best fit with a standard deviation of 25% for Industrial-General and 35% for Industrial-Tech. Commercial and public content uncertainties were set equal to structure percent (based on findings from other studies to include Hamilton City, Sacramento River-Phase V, Sacramento and San Joaquin River Comprehensive study) and ranged from 12% to 16% fitting a normal distribution.

The GRR's database was developed through an assessor's parcel database with an onsite survey (Section 2.2 Economic Appendix). Foundation heights come from the survey and topographic data was developed within GIS mapping of land and parcel boundaries. Uncertainty in first floor elevation was based on topography used in both the hydraulics and structural analysis. The standard deviation of first floor elevation was estimated at 0.1 feet in accordance with EM 1110-2-1619.

For single family residential depth-damage functions, uncertainties were based on the standard deviations provided in EGM 01-03 (varies by depth, with a maximum of 5%). Uncertainties for depth-damage percentages for commercial, industrial and public structures were triangular error functions based on prior Sacramento District studies.

4.3 Other Damage Categories

In addition to damages directly related to structures and their contents, losses were estimated for other categories such as damages to automobiles and emergency costs. While economic uncertainties for these damage categories are not specifically identified or required in EM 1110-2-1619, uncertainty parameters for these categories were included in this study.

Losses to automobiles were determined as a function of the number of vehicles per residence, average value per automobile, estimated percentage of autos removed from area prior to inundation, and depth of flooding above the ground elevation. Depth-damage relationships for autos were taken EGM 09-04. Source of vehicle counts per housing unit were taken from the US Census 2000 (San Jose and Milpitas averages). Evacuation (autos moved out of the flooded area) was assumed to be a triangular distribution with the most likely value set at 50%. The assumption is that there are many factors that could determine ability to evacuate and 50% has been used as an average on most Sacramento District studies. Depreciated replacement value of autos was based on average used car prices (taken from prior studies and updated using Bureau of Labor Statistics CPI-Used Vehicles) and was set at \$12,250. This value within HEC-FDA was assumed to be normally distributed with a standard deviation of 30%.

Emergency costs were estimated for the relocation and emergency services provided for those displaced both during the peak flood event and during post-flood structural renovations. Duration of services was formulated for two groups: short-term- residents evacuated for the duration of the flood but able to stay in the home once the flood recedes, and long-term- occupants displaced from the home due to inundation requiring repair and decontamination prior to return. Losses per resident per day were taken from prior

Sacramento District studies (Napa River, South Sacramento County Streams) with a mean of \$12 per day. Long-term dislocation was estimated based on a triangular distribution with the most likely value set at 45 days. Occupants per residential unit were taken from the US Census 2000 for the Milpitas area. Based on these estimates, a residence inundated above the first floor requiring repair would face an average \$1,950 in total emergency costs which is reasonable for the magnitude of flooding in the study area and is less than the national FEMA average for temporary rental and public assistance.

4.4 Stage-Damage Functions

Base damages (calculations without considering uncertainty, levees, or top of bank elevations) were estimated by the HEC-FDA model for each category by impact area and by event based on varying depths within the floodplain relative to individual structures. These damages are contained in the output file *FDA_StrucDetail.out* for each impact area displayed in the following tables.

Table 4.1 Stage-Damage Functions Impact Area A

Damages in \$1,000's, October 2011 Prices								
Damage Category	Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)							
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.002
	213.7	214.28	215.12	216.88	219.26	220.15	221.39	222.31
Single Family Residential	0	86	86	87	159	707	1,191	1,350
Multi-Family Residential	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0
Automobile	0	11	12	12	19	76	130	144
Emergency	0	4	4	4	5	13	16	20
Total	0	101	102	102	183	796	1,337	1,514

Table 4.2 Stage-Damage Functions Impact Area B

Damages in \$1,000's, October 2011 Prices								
Damage Category	Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)							
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.002
	146.06	146.79	147.06	147.49	147.69	147.74	147.81	147.83
Single Family Residential	0	0	0	0	933	2,410	3,093	3,504
Multi-Family Residential	0	0	0	835	2,552	4,097	5,212	5,829
Commercial	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	29	1,003	1,620
Automobile	0	0	0	81	445	970	1,310	1,580
Emergency	0	0	0	26	197	387	493	594
Total	0	0	0	942	4,127	7,893	11,112	13,127

Table 4.3 Stage-Damage Functions Impact Area C

Damages in \$1,000's, October 2011 Prices								
Damage Category	Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)							
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.002
	145.40	146.09	146.34	146.70	146.89	146.91	146.93	146.94
Single Family Residential	0	0	0	10	28	197	244	325
Multi-Family Residential	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0
Automobile	0	0	0	0	3	21	27	35
Emergency	0	0	0	0	0	3	7	8
Total	0	0	0	10	31	221	278	368

Table 4.4 Stage-Damage Functions Impact Area D

Damages in \$1,000's, October 2011 Prices								
Damage Category	Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)							
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.002
	146.06	146.79	147.06	147.49	147.69	147.74	147.81	147.83
Single Family Residential	0	53	54	253	1,019	4,534	9,726	13,797
Multi-Family Residential	0	0	0	0	0	382	1,637	2,857
Commercial	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0
Automobile	0	5	5	18	81	627	1,640	2,548
Emergency	0	2	3	3	11	151	415	630
Total	0	60	61	274	1,111	5,694	13,418	19,832

Table 4.5 Stage-Damage Functions Impact Area E

Damages in \$1,000's, October 2011 Prices								
Damage Category	Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)							
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.002
	61.63	62.59	63.58	64.50	64.71	64.86	65.01	65.07
Single Family Residential	0	0	21	2,076	4,700	12,538	20,529	25,199
Multi-Family Residential	0	0	0	0	661	5,007	6,749	9,849
Commercial	0	0	495	2,584	5,516	9,622	14,069	22,190
Industrial	0	0	3	3,539	8,499	15,771	22,612	26,822
Public	0	0	21	96	428	1,074	2,476	3,885
Automobile	0	0	4	265	848	2,474	4,076	5,015
Emergency	0	0	0	10	105	446	867	1,101
Total	0	0	544	8,570	20,757	46,932	71,378	94,061

Table 4.6 Stage-Damage Functions Impact Area F

Damages in \$1,000's, October 2011 Prices								
Damage Category	Exceedance Probability of Event Followed By Corresponding Stage (elevation in feet)							
	0.500	0.200	0.100	0.040	0.020	0.010	0.005	0.002
	36.80	37.76	37.86	38.13	38.21	38.31	38.33	38.35
Single Family Residential	0	0	0	0	0	0	40	40
Multi-Family Residential	0	0	0	0	0	0	0	0
Commercial	0	430	762	734	1,424	2,882	3,508	3,812
Industrial	0	12,778	26,885	46,679	57,869	71,041	86,511	93,074
Public	0	11	432	486	507	1,134	1,368	1,385
Automobile	0	0	0	0	0	0	0	0
Emergency	0	0	0	0	0	0	0	0
Total	0	13,220	28,079	47,898	59,800	75,057	91,426	98,311

CHAPTER 5: FUTURE ECONOMIC DEVELOPMENT

5.1 Midtown Redevelopment

The city of Milpitas currently has a redevelopment plan for Midtown area, with some of the land lying within economic impact area E of this study. Primarily along the South Main and Abel Street corridors, the plan calls for renovation of many of the existing buildings and new high density residential and commercial construction on existing vacant acres near light rail and proposed BART stations. This area is the only portion of the study floodplain identified for future growth. Development is projected to be complete by 2020.

5.2 Vacant Acres and Proposed Land Use

Land use plans for the Midtown area were taken from the Milpitas Midtown Specific Plan (MMSP) (April 2002) and were compared with vacant parcels within the impact area. The MMSP identifies location specific use and density. Nearly fifty acres were identified for residential development ranging from medium to very high density multi-family. Most of the commercial redevelopment involved existing structures but parcels were identified with just over seven vacant acres for new commercial. Based on these acreages and densities found in the MMSP, about 1,900 of the Midtown's proposed 4,800 residential units could be in the floodplain and around 83,000 square feet of new commercial buildings. Values per square foot were taken from M&S by structure type and structure values were determined based on the estimated square footage (without any depreciation). With over 2,000,000 square feet of additional multi-family units, future residential structures were estimated at over \$200 million. Future commercial structures were valued just over \$10 million. Total additional value to the future inventory of damageable property was estimated to be over \$320 million including both residential and commercial structure and content.

5.3 Inundation Damages – 100-year Event

In accordance with Corps guidance (reference ER-1105-2-100 paragraph E-19j), no structural damages were estimated for future development from the 100-year event. The analysis assumes that all construction would have ground elevations raised one foot above the 100-yr water surface elevation and typical construction would occur over this elevation for commercial and residential structures in compliance with this guidance.

CHAPTER 6: EXPECTED ANNUAL DAMAGES – WITHOUT-PROJECT CONDITIONS

6.1 HEC-FDA Model

Expected annual damages were estimated using the US Army Corps of Engineers risk-based Monte Carlo simulation program called HEC-FDA. The HEC-FDA program integrates hydrology, hydraulics, geo-technical and economic relationships to determine damages, flooding risk and project performance. Uncertainty is incorporated for each relationship, and the model samples from a distribution for each observation to estimate damage and flood risk. The Berryessa Creek model includes the following relationships for each economic impact area:

- Probability-Discharge (with uncertainty determined by period of record)
- Stage-Discharge (stage in the channel with estimated error in feet)
- Stage-Damage (computed internally within HEC-FDA)

These relationships for each economic impact area are shown in Attachment A of this economic appendix. The hydrologic and hydraulic data was provided by study team members and included in the HEC-FDA model.

6.2 Estimation of Expected Annual Damages

HEC-FDA integrates the probability-discharge, stage-discharge and stage-damage relationships to determine a probability-damage function. Expected annual damages (EAD) are calculated as the numerical integration of the area under the probability-damage curve. The dotted lines in the Figure 6.1 below represent the uncertainty band around each relationship with EAD represented as the area under a range of simulated damage-probability curves.

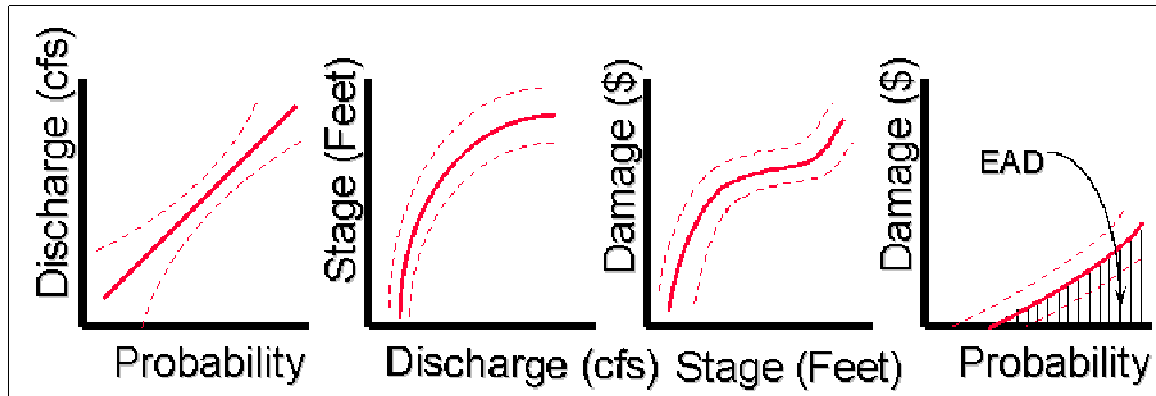


Figure 6.1 Uncertainty in Discharge, Stage and Damage in Determination of Expected Annual Damages

The derived probability damage function from the HEC-FDA model for each impact area is provided in Table 6.1. These damage values differ from the calculated damages by event shown in the stage-damage curves due to uncertainties in each relationship.

Table 6.1 Without-Project Probability Damage – HEC-FDA Model

October 2011 Prices, in \$ 1,000's						
Exceedance Probability	Total Damages by Economic Impact Area					
	A	B	C	D	E	F
0.200	0	0	0	0	0	0
0.100	0	221	11	116	0	0
0.050	0	11,423	506	13,475	4,522	0
0.040	0	15,046	659	18,765	15,843	0
0.020	171	22,292	967	29,346	141,546	102,657
0.015	333	24,104	1,043	31,991	228,245	157,756
0.010	837	25,916	1,120	34,636	314,944	212,855
0.004	1,447	28,089	1,212	37,810	418,983	278,974
0.002	2,897	28,814	1,243	38,868	453,662	301,014
0.001	4,333	29,176	1,258	39,397	471,002	312,034

EAD, under existing without project conditions, was estimated for each damage category for all six impact areas. Results are summarized in the Table 6.2 below.

Table 6.2 Expected Annual Damages Existing Without-Project Conditions

October 2011 Prices, 3.75% Interest Rate, 50 Year Period of Analysis, Values in \$ 1,000's							
Damage Category	EAD by Economic Impact Area						
	A	B	C	D	E	F	Total
Single Family Residential	20	282	37	1,008	987	3	2,337
Multi-Family Residential	0	453	0	178	518	0	1,149
Commercial	0	0	0	0	1,370	374	1,744
Industrial	0	0	0	0	1,792	6,071	7,863
Public	0	133	0	0	166	118	417
Automobile	2	136	4	185	251	0	578
Emergency	0	50	1	47	43	0	141
Total EAD	22	1,054	42	1,418	5,127	6,566	14,229

6.3 EAD Future Conditions

Future development was estimated out to the year 2020, representing full build-out for the Milpitas Midtown area (see Chapter 5). Future developments for this area were entered into the HEC-FDA model and EAD values were calculated for the future without project economic condition. Future hydrology was evaluated in hydrology and hydraulic studies, which concluded that the change in flow would be insignificant. Therefore, all increases in EAD under future conditions were attributable to future growth. Existing and future EAD estimates for the area of development are displayed in Table 6.3. The average annual equivalent represents the present value of future damages amortized over the 50 year period of economic analysis at the fiscal year 2013 federal discount rate of 3.75%. The increased (future at full build out) damages need to be brought back to the study year of 2011 in present value terms. Total EAD future (2020) listed in Table 6.3 is amortized over the period of analysis to arrive at average annual equivalent damages. The closer the growth is in timeline to the base year the less discounting occurs. More time between base year and most likely future the greater the discounting.

Table 6.3 Average Annual Equivalent Damages Future-Without Project Conditions

Values in \$ 1,000's, October 2011 Prices, 3.75% Interest Rate, 50-Year Period of Analysis				
Damage Category	Expected Annual Damages			Average Annual Equivalent @ 3.75%
	Existing	Future Midtown (2020)	Total EAD Future (2020)	
Single Family Residential	987	0	987	987
Multi-Family Residential	518	157	675	644
Commercial	1,370	6	1,376	1,375
Industrial	1,792	0	1,792	1,792
Public	166	0	166	166
Automobile	251	0	251	251
Emergency	43	0	43	43
Total EAD	5,127	163	5,290	5,258

6.4 Project Performance- Without Project Conditions

In addition to damages estimates, HEC-FDA reports flood risk in terms of project performance. Three statistical measures are provided, in accordance with ER 1105-2-101, to describe performance risk in probabilistic terms. These include annual exceedance probability, long-term risk, and assurance by events.

- Annual exceedance probability measures the chance of having a damaging flood in any given year.
- Long-term risk provides the probability of having one or more damaging floods over a period of time.
- Assurance probability indicates the chance of not having a damaging flood given a specific magnitude event.

Project performance for each impact area is displayed in Table 6.4 below.

Table 6.4 Project Performance – Without-Project Conditions

Economic Impact Area	Annual Exceedance Probability	Long-Term Risk			Assurance Probability by Events			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2 %
A	0.0336	29%	57%	82%	99%	31%	9%	1%
B	0.1964	89%	100%	100%	42%	20%	19%	18%
C	0.2461	94%	100%	100%	35%	18%	17%	17%
D	0.1967	89%	100%	100%	42%	20%	19%	18%
E	0.0696	51%	84%	97%	68%	27%	22%	18%
F	0.0292	26%	52%	77%	88%	83%	82%	79%

CHAPTER 7: WITH-PROJECT CONDITIONS – FLOOD RISK MANAGEMENT BENEFITS

7.1 Project Benefits – The Role of Economics in the Plan Formulation Process

This section will describe how benefits of flood damage reduction of various potential alternatives were estimated. In this section, benefits and project performance outputs will be limited to flood risk management components. Non-monetary outputs such as environmental benefits, which may vary for the final array of alternatives, are not included but may factor in the plan formulation decision process.

On Berryessa Creek, flood risk management measures have been considered and screened during several phases of the study. A description of all management measures and the screening process can be found in the Main Report. In this section flood risk management benefits have been explicitly calculated for the measures that might be feasible and have been carried forward in the plan formulation. Those measures that have been screened out are not included in this appendix.

An incremental analysis examining project location and sizing was conducted with near final H&H and economics. The final changes in H&H and economics were considered and deemed non-material to the overall outcomes of the HEC-FDA model and were not updated for this report given study constraints (budget and time). Although not updated, the previous incremental results are presented in Attachment C.

7.2 With Project Conditions - Model Simulations

Benefits were determined by making changes to the HEC-FDA model that represent various with project improvements. Flood damage reduction benefits equal the difference between the without project damage conditions and the with project residual damages.

With project residual damages were simulated for the alternatives using residual floodplain depths. The reduction in project floodplains in both extent and depth from the larger without project floodplains accounts for the decrease in damages of the given alternative. Residual depths for each damage area from the four alternative with project Flo2D runs were linked to the without project inventory through modified water surface elevation (WSE) profiles within the HEC-FDA model. With the new WSEs, stage-damages functions for the alternatives were computed within HEC-FDA and overall model runs were computed for the alternatives. Alternatives 2B and 4 do not have residual floodplains at the mean 500-yr event, the upper limit of the current HEC-FDA modeling effort. Thus, the HEC-FDA model was not run for alternatives 2B and 4 as no residual damages are present.

In addition to the modifications to the floodplains, changes to the stage-discharge function and/or top of bank (top of levee failure point) were made in the HEC-FDA model to simulate project conditions for any alternative that increased channel capacity (lowering water surface at a given exceedance probability) or raised levee height (increasing non-damaging

elevation.) Details of HEC-FDA with project inputs can be found in Attachment B of this appendix.

7.3 Average Annual Equivalent Damages –With Project Conditions

HEC-FDA was run simulating with project conditions for the alternatives considered. Residual with project damages were subtracted from the without project damages to determine flood risk management benefits. Frequency/discharge functions and stage/discharge functions were modified to simulate project conditions of the alternatives in the HEC-FDA model. All benefit values in the remaining tables of this report include average annual equivalents instead of expected annual damages. These average annual equivalent damages include future growth described in section 6.3. The future growth adds very little to the total damages (less than 1% of the total) and will not impact the plan formulation process.

7.4 Alternatives Evaluated – Flood Risk Management Benefits

Four alternatives, including the previous authorized plan, were analyzed for their flood damage reduction potential. These plans are:

- 1) Alternative 2A - Incised Trapezoidal Channel
- 2) Alternative 2B - Incised Trapezoidal Channel - Certification Level
- 3) Alternative 4 - Walled Trapezoidal Channel - Certification Level
- 4) Alternative 5 - The 1988 Authorized Plan

Damages as calculated by the HEC-FDA model for these alternatives are displayed in Table 7.1. Annual benefits in the table represent the difference between the without and with project equivalent annual damage.

Table 7.1 Annual Benefits by Alternative

Values in \$1,000's, October 2011 Prices, 4% Interest Rate, 50-Year Period of Analysis			
Alternative	Equivalent Annual Damages		Annual Benefits
	Without Project	With Project	
Upstream of I-680 - Damage Areas A, B, C, & D			
Without	2,537	2,537	0
1) Alt. 5	2,537	454	2,083
2) Alt. 2A	2,537	2,537	0
3) Alt. 2B	2,537	2,537	0
4) Alt. 4	2,537	2,537	0
Downstream of I-680 - Damage Areas E & F			
Without	11,823	11,823	0
1) Alt. 5	11,823	319	11,504
2) Alt. 2A	11,823	887	10,936
3) Alt. 2B	11,823	0.00	11,823
4) Alt. 4	11,823	0.00	11,823

7.5 Probability Distribution – Damages Reduced

In accordance with ER 1105-2-101, flood damage reductions were determined as mean values and by probabilities (75%, 50%, 25%) exceeding a specified value.

Table 7.2 shows the benefits derived by each alternative in the upstream area at probabilities of 75%, 50% and 25% that benefits will exceed the indicated value. Table 7.3 shows this distribution for the downstream area. The damage reduced column represents the mean benefits for each alternative and the 75%, 50% and 25% represent the probability that the flood damage reduction benefits exceed the number in that column for that alternative. For example, Alternative 5 upstream has an average (mean) benefit of \$2,083,000 but only a 50% chance that benefits will be greater than \$385,000 and 75% confidence that benefits will be equal or greater than \$309,000 and a 25% chance benefits will exceed \$2,556,000. This range is the probability distribution of damages reduced and represents the uncertainty in the benefit estimates and incorporates all the uncertainties in hydrology, hydraulics, and economics in the HEC-FDA model. The uncertainty in damages reduced should be considered when selecting an optimal plan during the plan formulation process. Judgment should be used to determine if an alternative meets a reasonable level of confidence regarding positive net benefits and identifying if changes in net benefits from alternative to alternative are significant.

Table 7.2 Equivalent Annual Damages Reduced Upstream

Values in \$1,000's, October 2011 Prices, 3.75% Interest Rate, 50 Year Period of Analysis Upstream of I-680 (Areas A, B, C, D)						
Alternative	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Without	2,537	2,537	0	0	0	0
1) Alt. 5	2,537	454	2,083	309	385	2,556
2) Alt. 2A*	2,537	2,537	0	0	0	0
3) Alt. 2B*	2,537	2,537	0	0	0	0
4) Alt. 4*	2,537	2,537	0	0	0	0
*These alternatives do not extend upstream into Reaches A, B, C & D						

Table 7.3 Equivalent Annual Damage Reduced Downstream

Values in \$1,000's, October 2011 Prices, 3.75% Interest Rate, 50 Year Period of Analysis Downstream of I-680 (Areas E, F)						
Alternative	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Without	11,823	11,823	0	0	0	0
1) Alt. 5	11,823	319	11,504	3,042	3,716	8,359
2) Alt. 2A	11,823	887	10,936	2,731	3,337	8,068
3) Alt. 2B	11,823	0	11,823	11,823	11,823	11,823
4) Alt. 4	11,823	0	11,823	11,823	11,823	11,823

7.6 Project Performance – With Project Conditions

Comparisons of project performance under both with and without project conditions by economic impact area are shown in Table 7.4 to Table 7.9. The annual exceedance probability measures the chance of having a damaging flood in any given year.

The long-term risk numbers measure the chance of having one or more damaging floods over a given period of time. As shown in Table 7.5, Alternative 2B reduces the chance of getting damaged (in impact area E) over the next 30 years from 84% under the without project condition to 0% with the project.

The assurance measures the probability of not being damaged if a given event were to occur. As with the other measures, project conditions reduce the risk and larger projects have a greater reduction in risk than smaller projects. Assurance for the 1% event is often targeted to determine if a project meets Corps criteria for levee certification. It is important to note the relationship between AEP and assurance in determining project accomplishment. For example, in impact Area E (see Table 7.8) Alternative 2A only provides a 73% chance of non-damage from a 1% event. To be 90% confident that the 1% event can pass without causing damage in impact Area E, a larger project must be constructed. This often causes confusion in how to identify the performance of a project in a single traditional term such as “100-year level of protection,” and as per the guidance ER 1105-2-101, the Corps has dropped all reference to describing level of protection.

Again, it is important to note that all of these statistics (AEP, long-term risk, and assurance) were calculated in HEC-FDA with uncertainties in hydrology, hydraulics and economics.

Table 7.4 Project Performance Impact Area A

With and Without Project Conditions								
Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.0336	29	57	82	99	31	9	1
1) Alt. 5	0.0052	5	12	23	100	98	83	37
2) Alt. 2A	0.0336	29	57	82	99	31	9	1
3) Alt. 2B	0.0336	29	57	82	99	31	9	1
4) Alt. 4	0.0336	29	57	82	99	31	9	1

Table 7.5 Project Performance Impact Area B

With and Without Project Conditions								
Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.1964	89	100	100	42	20	19	18
1) Alt. 5	0.2115	91	100	100	37	12	7	5
2) Alt. 2A	0.1964	89	100	100	42	20	19	18
3) Alt. 2B	0.1964	89	100	100	42	20	19	18
4) Alt. 4	0.1964	89	100	100	42	20	19	18

Table 7.6 Project Performance Impact Area C

With and Without Project Conditions								
Incremental Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.2461	94	100	100	35	18	17	17
1) Alt. 5	0.3418	98	100	100	32	13	9	7
2) Alt. 2A	0.2461	94	100	100	35	18	17	17
3) Alt. 2B	0.2461	94	100	100	35	18	17	17
4) Alt. 4	0.2461	94	100	100	35	18	17	17

Table 7.7 Project Performance Impact Area D

With and Without Project Conditions								
Incremental Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.1967	89	100	100	42	20	19	18
1) Alt. 5	0.2111	91	100	100	37	12	7	5
2) Alt. 2A	0.1967	89	100	100	42	20	19	18
3) Alt. 2B	0.1967	89	100	100	42	20	19	18
4) Alt. 4	0.1967	89	100	100	42	20	19	18

Table 7.8 Project Performance Impact Area E

With and Without Project Conditions								
Incremental Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.0696	51	84	97	68	27	22	18
1) Alt. 5	0.0062	6	14	27	100	94	70	53
2) Alt. 2A	0.0071	7	16	30	100	83	73	61
3) Alt. 2B	0.0000	0	0	0	100	100	100	100
4) Alt. 4	0.0000	0	0	0	100	100	100	100

Table 7.9 Project Performance Impact Area F

With and Without Project Conditions								
Incremental Alternative	Annual Exceedance Probability	Long-Term Risk %			Conditional Non-Exceedance Probability by Events %			
		10 Year Period	30 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.0292	26	52	77	88	83	82	79
1) Alt. 5	0.0000	0.02	0.06	0.11	100	100	100	100
2) Alt. 2A	0.0089	9	20	36	99	86	77	64
3) Alt. 2B	0.0000	0	0	0	100	100	100	100
4) Alt. 4	0.0000	0	0	0	100	100	100	100

7.7 Other Benefits

7.7.1 Savings in Flood Insurance Administration Costs

In the past, savings in the administration costs for the National Flood Insurance Program (NFIP) were considered in the determination of NED benefits. It was based on the assumption that any alternative that removes the FEMA requirement for flood insurance could claim this benefit by reducing the number of policies required thus marginally reducing the federal administration cost of the national program. Economic Guidance Memorandum 06-04 lists the current operating cost per policy at \$192 and this value was used in the benefit calculation (number of policies reduced times \$192). Based on the most recent FEMA data, Milpitas has 2,493 policies in force and based on the total estimated number of structures inundated from various sources to include Berryessa and Penitencia Creeks within Milpitas, the participation rate for the area in the NFIP would be around 40%. Using this participation rate, potential benefits from savings in NFIP administration costs may be around \$171,000 (\$46,000 upstream of I-680 and \$125,000 downstream) for any alternative that would remove all the existing structures in the Berryessa Study from the 100-year FEMA floodplain.

Recent guidance suggests that these savings should not be included in NED benefit determinations and are excluded from this analysis.

7.7.2 Advance Bridge Replacement Benefits

For many projects, relocations will result in the replacement of existing bridge facilities. Often the expected life of the replacement bridge will be greater than that of the existing structure, thereby extending the life of the bridge service being provided. Since the total cost of the new bridge is included in the first cost of the project, a credit for this extension is needed on the benefit side. A credit is also needed if any reduction in O&M costs will occur during the remaining life of the existing facility.

Calculation of replacement benefits is a function of interest rate, projected replacement bridge life, remaining bridge life and cost of replacement. In total, 4 bridges need to be replaced downstream of I-680. Following the procedures of IWR Report 88-R-2, "National Economic Development Procedures Manual – Urban Flood Damage," advance bridge replacement benefits for these bridges are shown in Table 7.10. In general, all of the bridges were constructed in the early 1970's and replacement will extend their lives beyond the study's period of analysis. The life extension within the period of analysis is estimated at 24 years. Benefits from an O&M change are not expected to occur with the bridge replacements.

Table 7.10 Advance Bridge Replacement Benefits

In Oct 2011 Prices, Using 3.75%, 50 Year Period of Analysis				
Downstream of I-680				
	Alt 2A Cost	Alts 2B & 4 Cost	Alt 2A Benefit	Alts 2B & 4 Benefit
Montague Expressway	-	\$3,041,550	-	\$36,300
UPRR Trestle	\$1,052,200	\$1,052,200	\$12,600	\$12,600
Los Coches Street	-	\$2,147,625	-	\$25,600
Calaveras Road	-	\$4,674,750	-	\$55,800
Alternative 5				
	Alt 5 Cost		Alt 5 Benefit	
Old Piedmont Bridge	\$708,589		\$8,500	
Montague Expressway	\$1,040,751		\$12,100	
UPRR Trestle	\$1,190,522		\$14,200	

7.7.3 Recreation Benefits

Improvement for flood risk management provides the opportunity for increased recreation uses in the study area. Improvement of the levees would allow for the extension of a local recreational trail. In less than one mile of the risk management improvements over 60,000 people reside, according to tract data of the 2000 Census. The estimated cost of trail construction on the improvement is \$1.63 million. The amortized value of this construction is less than \$76,000 or nearly \$1 per person in the immediate area. The FY12 unit day value for general recreation with a zero point value is \$3.72. Less than 60 users per day would be necessary for economic justification at this unit day value.

7.7.4 Environmental Benefits

Some of the alternatives provide incidental outputs in addition to flood damage reduction. These benefits are non-monetary and were not part of the economic analysis. Details of the Environmental Quality (EQ) account outputs of the various alternatives can be found in the Main Report.

7.7.5 Additional Flood Related Risks

In addition to the monetary losses to categories listed above, flooding from Berryessa Creek could have other damage impacts and place many public services at risk, and if reduced would provide additional non-monetary benefit. Emergency costs (about 1% of total damages) evaluated in this appendix were limited to evacuation, relocation and temporary assistance based on examples of similar flood risks found on other flood damage studies in Northern California. Administrative costs and increased public services such as police and fire were not included in these emergency cost estimates primarily due to lack of available

data regarding any comparable historical flooding within the Bay Area. Nationwide, where depth of flooding and duration of event were much greater, some studies have estimated total emergency costs (including temporary relocation, evacuation, public administration, additional emergency healthcare and increased labor) as high as 15% of the total without-project damages. While the emergency costs listed for Berryessa do not capture the total potential loss, these non-quantified losses are an incrementally-small portion of the overall losses and would not change the feasibility or formulation of any of the alternatives.

Potential traffic delays and temporary interruption in public services were also not quantified. Highway I-680 runs through the study area but would not be closed from flooding along Berryessa Creek. Minor roads within the floodplain may be closed for short durations due to flooding but alternate routes would not add significant time loss or additional resource consumption to the NED account and would not change the feasibility or formulation of any of the alternatives.

The area could suffer from significant business losses which could be included as Regional Economic Development (RED) damages in the analysis. But because most of these income losses could not be included in the NED analysis and therefore would not change the determination of the NED plan, RED benefits were not explicitly quantified for this document. Discussion of EQ, RED and Other Social Effects (OSE) accounts can be found in the Main Report.

Other non-monetary risks could also occur from a flood event but are not included in the NED evaluation. General reductions in risks to health, safety and public welfare are typically associated with flood conditions and are further reasons why flood protection serves the federal interest and the public good. Within the Berryessa Creek floodplain there are several elementary schools, two fire stations, a hospital, several medical clinics, police station and Milpitas City Hall that could lose vital public services due to flooding at least one-foot above the first floor.

CHAPTER 8: BENEFIT COST ANALYSIS – NED PLAN IDENTIFICATION

ER 1105-2-100 requires the identification of the plan that maximizes net annual benefits as the NED plan. Economic feasibility and project efficiency are determined through benefit cost analysis. For a project or increment to be feasible, benefits must exceed costs and the most efficient alternative is the one that maximizes net benefits (annual benefits minus annual costs.) The NED plan serves as the basis for federal participation. Deviations from the NED plan, as with a case of a locally preferred alternative, are measured from the NED plan for federal cost sharing allocations.

8.1 Annual Costs

With benefits calculations complete, annual costs need to be derived to complete the benefit cost analysis. Project costs were developed for the four alternatives. The project features unique to each alternative are summarized below:

- *Alternative 1 (No Action).* Without-project condition, assuming routine maintenance.
- *Alternative 2 (Incised Trapezoidal Channel).* Earthen trapezoidal section with varying bottom width and 2:1 side slopes. Access road intermittently along one or both banks, within channel at approximate level of 0.04 exceedance probability event, or both. Cellular bank stabilization with rip rap toe protection throughout. Levees with 2:1 to 3:1 side slopes and 12' top width or floodwalls as required.
- *Alternative 4 (Walled Trapezoidal Channel).* 10' bottom width earthen low-flow channel with 3:1 side slopes, 3' deep. Two vegetated floodplain benches bounded by vertical concrete floodwalls, 32' bench width on the left bank, and 10' width on the right bank. Access road location varies. Wall extensions as required to contain flows.
- *Alternative 5 (Authorized Plan).* Sediment basin upstream of Old Piedmont, earthen levees in the Greenbelt, concrete trapezoidal channel downstream of I-680.

Appendix B Part IV, Design and Cost Alternatives reports the total construction costs for each alternative as shown in Table 8.1.

Table 8.1 Summary of Construction Cost by Alternative

October 2012 Price Level, 3.75% Interest Rate, 50 Year Period of Analysis				
Item	Alt - 2A	Alt - 2B	Alt - 4	Alt - 5
Total Construction Cost	\$9,268,000	\$26,046,000	\$45,733,000	\$25,890,000
Contingency	\$1,947,000	\$10,178,000	\$17,638,000	\$8,991,000
Design Phase/PED	\$1,698,000	\$4,773,000	\$8,381,000	\$4,745,000
Construction Mgt-Inspection & Admin/SI/SA	\$1,066,000	\$3,046,000	\$5,348,000	\$3,027,000
LERRD Acquisition Costs	\$9,828,000	\$15,137,000	\$14,965,000	\$46,190,000
LERRD Administrative Costs	\$1,250,000	\$1,250,000	\$1,220,000	\$2,080,000
Recreation Facilities	\$1,626,000	\$1,626,000	\$1,626,000	\$0
Total First Cost	\$26,683,000	\$62,056,000	\$94,911,000	\$90,923,000
Interest During Construction (IDC)	\$1,001,000	\$2,327,000	\$3,559,000	\$3,410,000
Total Project Economic Cost	\$27,684,000	\$64,383,000	\$98,470,000	\$94,333,000
Annualized Project Economic Cost	\$1,234,000	\$2,870,000	\$4,389,000	\$4,205,000
Annual OMRR&R	\$63,000	\$79,000	\$89,000	\$128,000
Total Annual Economic Cost	\$1,297,000	\$2,949,000	\$4,478,000	\$4,333,000

Interest during construction (IDC) for these alternatives is based on a 2 year midlife full expenditure approach.

8.2 Net Annual Benefits

Economic efficiency is measured based on the maximization of project net benefits. Net benefits are determined as the difference between the annual benefits and the annual costs of an alternative. Table 8.2 shows equivalent damage reductions and Table 8.3 shows net benefits and the benefit-cost ratio for each alternative.

Table 8.2 Equivalent Annual Damage Reduced

Values in \$1000s, October 2011 Prices, 3.75% Interest Rate, 50 Year Period of Analysis						
	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Alt 1: No Action	14,360	14,360	0	-	-	-
Alt 2A/downstream	11,824	887	10,937	2,731	3,337	8,068
Alt 2B/downstream	11,824	0	11,824	n/a	n/a	n/a
Alt 4/downstream	11,824	0	11,824	n/a	n/a	n/a
Alt 5: Authorized Plan	14,360	773	13,587	3,351	4,100	10,915

Table 8.3 Annual Benefits and Costs by Alternative

Values are in October 2012 Prices in \$1000s Based on a 50-year Period of Analysis (Discounted using 3.75 % interest rate)				
Item	Alt 2A	Alt 2B	Alt 4	Alt 5
Total Project Cost	27,684	64,383	98,470	96,020
Annual Benefits Flood Damage Reduction ²	10,937	11,824	11,824	13,587
Savings in NFIP Administration Costs	0	0	0	0
Advanced Bridge Replacement	13	130	130	35
Total Annual Benefits	10,950	11,954	11,954	13,622
Total Annual Costs	1,297	2,949	4,478	4,333
Net Benefits	9,653	9,005	7,476	9,289
B/C Ratio	8.44	4.05	2.67	3.14
Alternative 2A under OMB's 7% rate				
Annual Benefits	10,944			
Annual Costs	2,132			
Net Annual Benefits	8,812			
B/C Ratio	5.13			

The alternative that maximizes net annual benefits is Alternative 2A and as such is the NED plan. Alternative 2A is a Moderate Protection plan that includes channel modifications in addition to modifications and/or complete replacements at bridge and culvert crossings with the top of bank or top of levee/floodwall elevations set at the water surface level of the 0.01 exceedance probability event (100-year). The modifications or retrofits include shoring and transition structures, headwall extensions with transition structure, and bridge replacement (UPRR Trestle). Modifications within channel reaches include channel widening, bank stabilization, and levee/floodwall construction.

² Benefits include future development flood damage reduction benefits.

Reach A								
Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	30 Year Period	50 Year Period	10%	2%	1%	0.20%
Without	0.0336	0.2896	0.5746	0.8190	0.9896	0.3067	0.0917	0.0102
Alt - 5	0.0052	0.0505	0.1215	0.2283	1.0000	0.9760	0.8270	0.3662
Reach B								
Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	30 Year Period	50 Year Period	10%	2%	1%	0.20%
Without	0.1964	0.8878	0.9958	1.0000	0.4237	0.2043	0.1938	0.1842
Alt - 5	0.2115	0.9071	0.9974	1.0000	0.3720	0.1200	0.0693	0.0518
Reach C								
Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	30 Year Period	50 Year Period	10%	2%	1%	0.20%
Without	0.2461	0.9407	0.9991	1.0000	0.3453	0.1813	0.1745	0.1682
Alt - 5	0.3418	0.9847	1.0000	1.0000	0.3232	0.1274	0.0875	0.0727
Reach D								
Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	30 Year Period	50 Year Period	10%	2%	1%	0.20%
Without	0.1967	0.8881	0.9958	1.0000	0.4232	0.2045	0.1941	0.1845
Alt - 5	0.2111	0.9067	0.9973	1.0000	0.3716	0.1199	0.0692	0.0517
Reach E								
Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	30 Year Period	50 Year Period	10%	2%	1%	0.20%
Without	0.0696	0.5138	0.8352	0.9728	0.6790	0.2716	0.2217	0.1781
Alt - 2A	0.0071	0.0692	0.1642	0.3015	0.9989	0.8343	0.7333	0.6058
Alt - 2B	Protection beyond the upper limit of HEC-FDA							
Alt - 4	Protection beyond the upper limit of HEC-FDA							
Alt - 5	0.0062	0.0601	0.1436	0.2666	1.0000	0.9974	0.6993	0.5309
Reach F								
Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	30 Year Period	50 Year Period	10%	2%	1%	0.20%
Without	0.0292	0.2567	0.5236	0.7730	0.8821	0.8304	0.8198	0.7852
Alt - 2A	0.0089	0.0856	0.2005	0.3608	0.9899	0.8627	0.7749	0.6377
Alt - 2B	Protection beyond the upper limit of HEC-FDA							
Alt - 4	Protection beyond the upper limit of HEC-FDA							
Alt - 5	0.0000	0.0002	0.0006	0.0011	1.0000	0.9997	0.9989	0.9978

ATTACHMENT A: H&H RELATIONSHIPS WITHOUT-PROJECT USED IN THE HEC-FDA MODEL

Along with the economic stage-damage functions, hydrologic and hydraulic functions are part of the flood damage analysis model. The probability-discharge, stage-discharge and interior-exterior stage relationships were provided and developed by the H&H members of the Berryessa study team. These relationships in Attachment A represent without project conditions.

A.1 Probability Curves

For Areas A-F, probability- discharge curves were developed for the HEC-FDA model. The discharge values in these relationships represent total flows both in channel and in the floodplain. Tables A1-A to A1-F display the probability functions for each damage area in the study.

Table A1-A: Probability-Discharge Area A

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	50	35	42	60	71
0.500	240	188	212	271	307
0.200	420	304	357	494	580
0.100	560	371	456	688	846
0.040	830	515	654	1054	1338
0.020	1090	642	837	1420	1850
0.010	1430	798	1068	1915	2564
0.004	1904	1000	1380	2628	3627
0.002	2142	1096	1532	2995	4186
0.001	2392	1194	1690	3385	4790

Table A1-B: Probability-Discharge Area B

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	50	35	42	60	72
0.500	252	196	222	285	323
0.200	444	318	376	525	620
0.100	603	399	491	741	911
0.040	886	551	698	1124	1426
0.020	1118	666	863	1449	1878
0.010	1180	695	906	1537	2003
0.004	1238	722	946	1620	2121
0.002	1252	729	955	1641	2150
0.001	1266	735	965	1660	2178

Table A1-C: Probability-Discharge Area C

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge Cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	50	35	42	60	72
0.500	252	196	222	285	323
0.200	444	318	376	525	620
0.100	603	399	491	741	911
0.040	886	551	698	1124	1426
0.020	1118	666	863	1449	1878
0.010	1180	695	906	1537	2003
0.004	1238	722	946	1620	2121
0.002	1252	729	955	1641	2150
0.001	1266	735	965	1660	2178

Table A1-D: Probability-Discharge Area D

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge Cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	50	35	42	60	72
0.500	252	196	222	285	323
0.200	444	318	376	525	620
0.100	603	399	491	741	911
0.040	886	551	698	1124	1426
0.020	1118	666	863	1449	1878
0.010	1180	695	906	1537	2003
0.004	1238	722	946	1620	2121
0.002	1252	729	955	1641	2150
0.001	1266	735	965	1660	2178

Table A1-E: Probability-Discharge Area E

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge Cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	200	164	181	221	243
0.500	488	420	453	526	566
0.200	698	533	610	798	913
0.100	953	691	812	1119	1314
0.040	1145	799	956	1370	1640
0.020	1398	931	1141	1712	2098
0.010	1544	1004	1245	1915	2375
0.004	1650	1055	1320	2063	2580
0.002	1771	1112	1403	2234	2818
0.001	1892	1168	1487	2407	3063

Table A1-F: Probability-Discharge Area F

Exceedance Probability	Total Discharge (cfs)	Confidence Limits (standard error) Discharge Cfs @ standard deviation(SD)			
		-2 SD	- 1 SD	+ 1 SD	+ 2 SD
0.999	100	63	80	126	158
0.500	678	550	611	752	834
0.200	924	705	807	1057	1210
0.100	1300	962	1118	1512	1758
0.040	1521	1105	1296	1783	2091
0.020	1550	1124	1320	1819	2136
0.010	1612	1164	1369	1896	2232
0.004	1741	1246	1473	2058	2434
0.002	1924	1359	1617	2289	2723
0.001	2113	1475	1765	2529	3027

A.2 Rating Curves- Stage vs. Discharge

The following Tables A3-A to A3-E show the stage-discharge functions with uncertainty used in the HEC-FDA model. Stage represents elevation in channel and discharge is flow in channel. Curves were developed for Areas A-F.

Table A3-A: Stage-Discharge Area A

Discharge in Channel (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	207.90	0.000
240	213.70	0.426
420	214.28	0.469
560	215.12	0.530
830	216.88	0.660
1090	219.26	0.835
1430	220.15	0.900
1820	221.39	0.900
2142	222.31	0.900

Table A3-B: Stage-Discharge Area B

Discharge (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	141.40	0.000
252	146.06	0.662
444	146.79	0.765
603	147.06	0.803
886	147.49	0.865
1118	147.69	0.896
1180	147.74	0.900
1233	147.81	0.900
1252	147.83	0.900

Table A3-C: Stage-Discharge Area C

Discharge (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	140.75	0.000
252	145.40	0.679
444	146.09	0.780
603	146.34	0.817
886	146.70	0.869
1118	146.89	0.897
1180	146.91	0.900
1233	146.93	0.900
1252	146.94	0.900

Table A3-D: Stage-Discharge Area D

Discharge (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	141.40	0.000
252	146.06	0.662
444	146.79	0.765
603	147.06	0.803
886	147.49	0.865
1118	147.69	0.896
1180	147.74	0.900
1233	147.81	0.900
1252	147.83	0.900

Table A3-E: Stage-Discharge Area E

Discharge (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	57.01	0.000
487.7	61.63	0.529
697.8	62.59	0.639
953.3	63.58	0.753
1144.7	64.50	0.858
1397.8	64.71	0.882
1544.2	64.86	0.900
1611.1	65.01	0.900
1770.5	65.07	0.900

Table A3-F: Stage-Discharge Area F

Discharge (cfs)	Stage in Channel (Feet)	Standard Deviation Of Error
10	31.10	0.000
677.5	36.80	0.712
923.5	37.76	0.831
1300.4	37.86	0.844
1520.5	38.13	0.878
1549.7	38.21	0.888
1611.5	38.31	0.900
1683.4	38.33	0.900
1923.9	38.35	0.900

ATTACHMENT B: HEC-FDA MODEL WITH-PROJECT MODIFIED RELATIONSHIPS

Project conditions were simulated in the model by making changes to the base relationships. For all alternatives, the stage-damage functions were modified to reflect depth of flooding under various project conditions. The exceedance probability – damage function from HEC-FDA for each alternative are shown in Tables B1-A to B1-F.

Table B1-A: Damage Area A - Mean Damages in \$1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	0	0	0	0	0
.04	0	0	0	0	0
.02	171	0	171	171	171
.01	837	0	837	837	837
.004	1,447	0	1,447	1,447	1,447
.002	2,897	931	2,897	2,897	2,897

Table B1-B: Damage Area B - Mean Damages in \$1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	221	0	221	221	221
.04	15,046	15	15,046	15,046	15,046
.02	22,292	4,296	22,292	22,292	22,292
.01	25,916	11,658	25,916	25,916	25,916
.004	28,089	15,545	28,089	28,089	28,089
.002	28,814	16,841	28,814	28,814	28,814

Table B1-C: Damage Area C - Mean Damages in \$1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	11	0	11	11	11
.04	659	35	659	659	659
.02	967	403	967	967	967
.01	1,120	588	1,120	1,120	1,120
.004	1,212	699	1,212	1,212	1,212
.002	1,243	755	1,243	1,243	1,243

Table B1-D: Damage Area D - Mean Damages in \$1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	116	0	116	116	116
.04	18,765	712	18,765	18,765	18,765
.02	29,346	4,625	29,346	29,346	29,346
.01	34,636	11,810	34,636	34,636	34,636
.004	37,810	15,990	37,810	37,810	37,810
.002	38,868	17,384	38,868	38,868	38,868

Table B1-E: Damage Area E - Mean Damages in \$1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	0	0	0	0	0
.04	15,843	0	0	0	0
.02	141,546	0	0	0	0
.01	314,944	0	0	0	0
.004	418,983	26,761	22,016	0	0
.002	453,662	99,304	40,833	0	0

Table B1-F: Damage Area F - Mean Damages in \$1,000's

Frequency	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
.20	0	0	0	0	0
.10	0	0	0	0	0
.04	0	0	0	0	0
.02	102,657	0	0	0	0
.01	212,855	0	0	0	0
.004	278,974	0	127,319	0	0
.002	301,014	0	176,285	0	0

For some alternatives, top of bank/levee, stage-discharge, and inflow vs. outflow were modified to reflect channel and bank improvements. These modifications were incorporated into the HEC-FDA where applicable. Tables B2-A to F show the changes in flow and stage for each alternative. Table B3 lists the top of levee/failure damage elevation for each area and alternative.

Table B2-A: Total Discharge - Stage in Channel Area A

Without Project		Alt. 5		Alt. 2A		Alts. 2B & 4	
Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel
(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)
240	213.7	243	211.19	240	213.7	240	213.7
420	214.28	420	212.66	420	214.28	420	214.28
560	215.12	564	213.80	560	215.12	560	215.12
830	216.88	830	215.24	830	216.88	830	216.88
1,090	219.26	1,096	216.70	1,090	219.26	1,090	219.26
1,430	220.15	1,427	218.51	1,430	220.15	1,430	220.15
1,820	221.39	1,820	219.38	1,820	221.39	1,820	221.39
2,130	222.31	2,130	223.14	2,130	222.31	2,130	222.31

Table B2-B: Total Discharge - Stage in Channel Areas B & D

Without Project		Alt. 5		Alt. 2A		Alts. 2B & 4	
Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel
(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)
252	146.06	261	146.09	252	146.06	252	146.06
444	146.79	452	146.88	444	146.79	444	146.79
603	147.06	595	147.17	603	147.06	603	147.06
886	147.49	870	147.61	886	147.49	886	147.49
1118	147.69	1160	147.96	1118	147.69	1118	147.69
1180	147.74	1521	148.33	1180	147.74	1180	147.74
1233	147.81	1755	148.55	1233	147.81	1233	147.81
1252	147.83	1787	148.57	1252	147.83	1252	147.83

Table B2-C: Total Discharge - Stage in Channel Area C

Without Project		Alt. 5		Alt. 2A		Alts. 2B & 4	
Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel
(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)
252	145.40	261	146.09	252	145.40	252	145.40
444	146.09	452	146.10	444	146.09	444	146.09
603	146.34	595	146.36	603	146.34	603	146.34
886	146.70	870	146.78	886	146.70	886	146.70
1118	146.89	1160	147.02	1118	146.89	1118	146.89
1180	146.91	1521	147.27	1180	146.91	1180	146.91
1233	146.93	1755	147.42	1233	146.93	1233	146.93
1252	146.94	1787	147.44	1252	146.94	1252	146.94

Table B2-D: Total Discharge - Stage in Channel Area E

Without Project		Alt. 5		Alt. 2A		Alt. 2B		Alt. 4	
Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel
(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)
487.7	61.63	481.2	57.67	487.7	58.20	487.80	58.97	489.50	58.42
697.8	62.59	676.6	59.28	697.8	59.23	698.60	59.86	699.70	58.94
953.3	63.58	848.6	60.06	953.3	60.11	953.40	60.46	953.40	59.47
1144.7	64.50	1207.9	62.06	1144.7	61.07	1144.70	60.86	1144.70	59.98
1397.8	64.71	1525.6	63.12	1397.8	61.59	1399.50	61.39	1400.80	60.36
1544.2	64.86	1987.7	64.62	1544.2	64.15	1544.20	61.70	1544.20	61.00
1611.1	65.01	2310.7	65.32	1611.1	65.28	1611.20	62.49	1611.30	61.97
1770.5	65.07	2358.6	65.50	1770.5	65.48	1770.70	62.95	1770.70	62.55

Table B2-E: Total Discharge - Stage in Channel Area F

Without Project		Alt. 5		Alt. 2A		Alt. 2B		Alt. 4	
Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel	Total Discharge	Stage in Channel
(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)	(inflow)	(Feet)
677.5	36.80	685.4	34.14	676.7	35.01	676.40	34.84	674.00	36.52
923.5	37.76	1016.5	34.94	1020.0	35.94	1019.90	35.84	1016.10	37.37
1300.4	37.86	1192.6	35.32	1306.8	36.59	1312.00	36.53	1307.40	37.97
1520.5	38.13	1685.8	36.29	1690.6	37.53	1696.60	37.45	1686.20	38.91
1549.7	38.21	1963.6	36.78	1895.8	37.86	1902.30	37.83	1886.60	39.36
1611.5	38.31	2340.8	37.35	2189.7	38.20	2206.10	38.19	2194.60	39.83
1683.4	38.33	2623.3	37.75	2586.9	38.56	2658.80	38.65	2638.10	40.43
1923.9	38.35	2826.1	37.99	2861.1	38.73	2975.50	38.93	2946.70	40.80

Table B3: Top of Levee Elevations**Damage Failure Points by Alternatives and Areas**

Damage Area	Without Project	Alt. 5	Alt. 2A	Alt. 2B	Alt. 4
A	217.90	220.50	217.90	217.90	217.90
B	146.90	146.90	146.90	146.90	146.90
C	146.00	146.00	146.00	146.00	146.00
D	146.90	146.90	146.90	146.90	146.90
E	64.07	65.15	65.27	65.50	66.01
F	39.00	40.42	38.88	41.35	43.80

ATTACHMENT C: INCREMENTAL ANALYSIS (PRELIMINARY F4A REPORT JUNE 2006)

C.1 Incremental Alternatives (Preliminary)

Benefits were calculated on incremental basis. The first was to determine feasibility of separable geographic areas: downstream of I-680 and upstream of I-680. The second was to determine optimal project sizing.

The goal of this incremental benefit analysis is to answer two simple questions: WHERE and HOW BIG? Is there a federal interest to construct a continuous project providing flood damage reduction to all impact areas? And what is the optimal size of project for these areas? For this analysis, benefits were evaluated for basic trapezoidal earthen channel improvements with varying capacity to reflect different sizing. Additional improvements such as levees and bridge improvements were added to some reaches or creek sections of the channel when needed to allow for full target conveyance (a more complete description of improvements required to meet conveyance can be found in Appendix B: Engineering Part IV Design and Cost of Alternatives.)

C.2 Project Conditions- Model Simulations

Benefits were determined by making changes to the economic model that represent various with project improvements. Flood damage reduction benefits equal the difference between the without project damage conditions and the with project residual damages.

With project residual damages were simulated for the incremental alternatives using residual floodplain depths. The reduction in project floodplains in both extent and depth from the larger without project floodplains accounts for the decrease in damages of the given alternative. Residual depths from five different sized with project Flo2D (see Appendix B Part I and II) runs for each damage area were linked to the without project inventory and the @RISK model was rerun to determine mean and standard deviation for the residual damage. From the @RISK output, with project stage-damage curves were generated for entry in the HEC-FDA model.

In addition to the modifications to the floodplains, changes to the stage-discharge function and/or top of bank (top of levee failure point) were made in the HEC-FDA model to simulate project conditions for any alternative or incremental measure that increased channel capacity (lowering water surface at a given exceedance probability) or raised levee height (increasing non-damaging elevation.) Details of HEC-FDA with project inputs can be found in Attachment B of this appendix.

C.3 Average Annual Equivalent Damages –With Project Conditions

For the preliminary alternatives considered, HEC-FDA was run simulating with project conditions. The residual with project damages were subtracted from the without project damages to determine flood damage reduction benefits. Total discharge- flow in channel, stage-discharge, and interior-exterior stage relationships were modified to simulate these project conditions in the HEC-FDA model. All benefit values in the remaining tables of this report included average annual equivalents instead of expected annual damages. These average annual equivalent damages include future growth described in section 6.3. The future growth adds very little to the total damages (less than 1% of the total) and will not impact the plan formulation process.

C.4 Alternatives Evaluated – Incremental Benefit Analysis

Incremental benefit evaluation to determine the optimal NED plan was formulated based on reasonable separable project features and sizing. The damage areas upstream of I-680 and downstream of I-680 are hydraulically independent and were separated into two groups:

Upstream – Areas A, B, C, & D

Downstream – Areas E & F

See Figure 1 for location of each impact area. Features were identified and categorized based on potential flood reduction and magnitude of cost. Exceedance probability of breakout by location, constriction, component costs and project performance goals were all used to select reasonable increments for benefit evaluation. Details of the project components and selection can be found in the main report. After preliminary iterations, with project residual damages were modeled for the following increments:

- 1) Project designed to pass flows (without uncertainty) equivalent to a minimum of 0.03 exceedance probability.
- 2) Project designed to pass flows (without uncertainty) equivalent to a minimum of 0.02 exceedance probability.
- 3) Project designed to pass flows (without uncertainty) equivalent to a minimum of 0.01 exceedance probability.
- 4) Additional components to the 0.01 project design to meet project performance criteria of 90% Conditional Non-Exceedance Probability of the 0.01 exceedance probability event.
- 5) Additional components to the 0.01 project design to meet project performance criteria of 95% Conditional Non-Exceedance Probability of the 0.01 exceedance probability event.

In total, ten project increments were run (five sizes each for the two separable areas) in HEC-FDA with the residual damages and benefits displayed in Table 17. Annual benefits in the table, represent the difference between the without and with project equivalent annual damages for each alternative row. The incremental benefits show the difference between

benefits from one incremental alternative to the next larger increment. It should be noted that alternatives beyond the 0.01 exceedance probability provide diminishing returns. The greatest benefit increments are realized as the more frequent floods are reduced. The channel improvements not only eliminate damages from the more frequent events but also reduce the magnitude of damage for the larger residual events.

Table 17
Annual Benefits by Increment
Values in \$1,000's, October 2005 Prices,
5 3/8 % Interest Rate, 50 Year Period of Analysis

Increment/ Alternative	Equivalent Annual Damages		Annual Benefits	Incremental Benefits
	Without Project	With Project		
Upstream of I-680 – Damage Areas A, B, C, D				
Without	581	581	0	0
1) Pass 0.03 exceedance probability	581	326	255	255
2) Pass 0.02 exceedance probability	581	280	301	46
3) Pass 0.01 exceedance probability	581	65	516	215
4) Meet 90% CNP	581	14	567	51
5) Meet 95% CNP	581	10	571	4
Downstream of I-680 – Damage Areas E, F				
Without	9,863	9,863	0	0
1) Pass 0.03 exceedance probability	9,863	5,643	4,220	4220
2) Pass 0.02 exceedance probability	9,863	3,981	5,882	1662
3) Pass 0.01 exceedance probability	9,863	530	9,333	3451
4) Meet 90% CNP	9,863	160	9,703	370
5) Meet 95% CNP	9,863	60	9,803	100

C.5 Probability Distribution – Damages Reduced

In accordance with ER 1105-2-101, flood damages reduced were determined as mean values and by probability exceeded. Table 18 shows benefits for each upstream increment for the 75%, 50% and 25% probability that benefit exceeds indicated value. Table 19 shows this probability distribution for the downstream increments. The damage reduced column represents the mean benefits for each increment and the 75%, 50% and 25% represent the probability that the flood damage reduction benefits exceed the number in that column for that increment. For example, the upstream increment designed to pass the 0.01 exceedance probability event has an average (mean) benefit of \$516,000 but only a 50% chance that benefits will be greater than \$435,000 and 75% confidence that benefits will be equal or greater than \$258,000 and a 25% chance benefits will exceed \$681,000. This range is the probability distribution of damages reduced and represents the uncertainty in the benefit estimates and incorporates all the uncertainties in hydrology, hydraulics, and economics in the HEC-FDA model. The uncertainty in damages reduced should be considered when selecting an optimal plan during the plan formulation process. Judgment should be used to determine if an alternative meets a reasonable level of confidence regarding positive net benefits and identifying if changes in net benefits from alternative to alternative are significant.

Table 18
Equivalent Annual Damage Reduced
Values in \$ 1,000's, October 2005 Prices
Upstream of I-680 (Areas A, B, C, D)

Increment	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Without	581	581	0	0	0	0
1) Pass 0.03 exceedance probability	581	326	255	173	250	320
2) Pass 0.02 exceedance probability	581	280	301	199	291	378
3) Pass 0.01 exceedance probability	581	65	516	258	435	681
4) Meet 90% CNP	581	14	567	268	465	752
5) Meet 95% CNP	581	10	571	268	468	760

Table 19
Equivalent Annual Damage Reduced
Values in \$ 1,000's, October 2005 Prices
Downstream of I-680 (Areas E, F)

Increment	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Without	9,863	9,863	0	0	0	0
1) Pass 0.03 exceedance probability	9,863	5,643	4,220	2,760	3,771	5,254
2) Pass 0.02 exceedance probability	9,863	3,981	5,882	3,707	5,262	7,570
3) Pass 0.01 exceedance probability	9,863	530	9,333	5,170	7,924	12,185
4) Meet 90% CNP	9,863	160	9,703	5,292	8,185	12,715
5) Meet 95% CNP	9,863	60	9,803	5,316	8,262	12,862

C.6 Project Performance – With Project Conditions

The following Tables 20-25 show a comparison of project performance under both with and without project conditions by economic impact area (see Section 6.4 for overview of terms). The annual exceedance probability measures the chance of having a damaging flood in any given year. As larger increments are analyzed, the annual exceedance probability (AEP) drops (for example-impact area A goes from a 1 in 25 chance without project to a 1 in 500 chance for the largest project) representing a decrease in flood risk.

The long-term risk numbers measure the chance of having one or more damaging flood over a given period of time. As shown in Table 21, building a project that will pass the 0.01 exceedance probability event reduces the chance of getting damaged (in impact area B) over the next 25 years from 94% under the without project condition to only 23 % with the project.

The conditional non-exceedance probability (CNP) measures the probability of not being damaged if a given event were to occur. As with the other measures, project conditions reduce the risk and larger projects have a greater reduction in risk than small projects. The CNP for the 1% event is often targeted to determine if a project meets Corps criteria for levee certification. It is important to note the relationship between AEP and CNP in determining project accomplishment. For example, in impact area d (see Table 23) the project that has an AEP of 0.01 (1%) only provides a 52% chance of non-damage from a 1% event. To be 95%

confident that the 1% event can pass without causing damage in impact area D, a much larger project with AEP of 0.002 (0.2%) must be constructed. This often causes confusion in how to identify the performance of a project in a single traditional term such as “100-year level of protection,” and as per the guidance ER 1105-2-101, the Corps has dropped all reference to describing level of protection.

Again, it is important to note, that all of these statistics (AEP, long-term risk, and CNP) were calculated in HEC-FDA with uncertainties in hydrology, hydraulics and economics.

Table 20
Project Performance With and Without Project Conditions
Impact Area A

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.040	33%	64%	87%	97%	23%	6%	1%
1) Pass 0.03 exceedance probability	0.040	33%	64%	87%	97%	23%	6%	1%
2) Pass 0.02 exceedance probability	0.024	21%	45%	70%	100%	51%	20%	2%
3) Pass 0.01 exceedance probability	0.011	11%	24%	43%	100%	86%	56%	15%
4) Meet 90% CNP	0.004	4%	9%	17%	100%	99%	90%	58%
5) Meet 95% CNP	0.002	2%	6%	11%	100%	100%	95%	79%

Table 21
Project Performance With and Without Project Conditions
Impact Area B

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.108	68%	94%	99%	51%	1%	0%	0%
1) Pass 0.03 exceedance probability	0.035	30%	59%	83%	98%	30%	9%	1%
2) Pass 0.02 exceedance probability	0.026	23%	48%	73%	99%	46%	17%	2%
3) Pass 0.01 exceedance probability	0.010	10%	23%	40%	100%	84%	52%	12%
4) Meet 90% CNP	0.004	4%	10%	18%	100%	99%	90%	49%
5) Meet 95% CNP	0.002	2%	6%	12%	100%	100%	95%	66%

Table 22
Project Performance With and Without Project Conditions
Impact Area C

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.047	38%	70%	91%	95%	14%	3%	0%
1) Pass 0.03 exceedance probability	0.035	30%	59%	83%	99%	26%	7%	1%
2) Pass 0.02 exceedance probability	0.020	18%	40%	64%	100%	58%	28%	8%
3) Pass 0.01 exceedance probability	0.013	12%	28%	47%	100%	79%	49%	15%
4) Meet 90% CNP	0.004	4%	9%	16%	100%	99%	90%	55%
5) Meet 95% CNP	0.002	2%	5%	9%	100%	100%	95%	73%

Table 23
Project Performance With and Without Project Conditions
Impact Area D

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.107	68%	94%	99%	51%	1%	0%	0%
1) Pass 0.03 exceedance probability	0.034	30%	58%	83%	98%	30%	9%	1%
2) Pass 0.02 exceedance probability	0.026	23%	48%	73%	99%	46%	17%	2%
3) Pass 0.01 exceedance probability	0.010	10%	22%	40%	100%	84%	52%	12%
4) Meet 90% CNP	0.004	4%	10%	18%	100%	99%	90%	49%
5) Meet 95% CNP	0.001	1%	3%	6%	100%	100%	95%	66%

Table 24
Project Performance With and Without Project Conditions
Impact Area E

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2%
Without	0.117	71%	96%	99%	52%	1%	0%	0%
a) Pass 0.03 exceedance probability	0.034	30%	58%	83%	99%	27%	3%	0%
b) Pass 0.02 exceedance probability	0.022	20%	43%	68%	100%	57%	14%	1%
c) Pass 0.01 exceedance probability	0.010	9%	22%	39%	100%	95%	53%	6%
d) Meet 90% CNP	0.004	4%	9%	17%	100%	100%	90%	30%
e) Meet 95% CNP	0.002	2%	5%	10%	100%	100%	95%	42%

Table 25
Project Performance With and Without Conditions
Impact Area F

Incremental Alternative	Annual Exceedance Probability	Long-Term Risk			Conditional Non-Exceedance Probability by Events			
		10 Year Period	25 Year Period	50 Year Period	10 %	2 %	1 %	0.2 %
Without	0.133	76%	97%	99%	43%	0%	0%	0%
a) Pass 0.03 exceedance probability	0.034	29%	58%	82%	98%	40%	17%	2%
b) Pass 0.02 exceedance probability	0.030	26%	53%	78%	99%	46%	21%	3%
c) Pass 0.01 exceedance probability	0.008	8%	18%	33%	100%	90%	56%	12%
d) Meet 90% CNP	0.002	2%	5%	10%	100%	99%	90%	43%
e) Meet 95% CNP	0.001	1%	3%	5%	100%	100%	95%	68%

ATTACHMENT D: VERIFICATION OF INCREASING NET BENEFITS

D.1 Analysis of Smaller Version of Identified NED Alternative – Alternative 2Aa

The main economic report's analysis identified Alternative 2A as the NED plan. To confirm Alternative 2A's selection, an additional analysis on optimization was conducted to ensure increasing net benefits by analyzing a smaller version (Alternative 2Aa) of the plan. The analysis of Alternative 2Aa followed the same procedures as with the other alternatives analyzed during this study. Engineering runs of hydrology & hydraulics were computed for this alternative and were compiled with the economic data within HEC-FDA. The results of the HEC-FDA model are shown in the table below.

Table 1
Equivalent Annual Damages – Alternatives 2A & 2Aa

Values in \$1,000's, October 2011 Prices, 4% Interest Rate, 50-Year Period of Analysis			
Alternative	Equivalent Annual Damages		Annual Benefits
	Without Project	With Project	
Upstream of I-680 - Damage Areas A, B, C, & D			
Without	2,536.73	2,536.73	0
Alt. 2A	2,536.73	2,536.73	0
Alt. 2Aa	2,536.73	2,536.73	0
Downstream of I-680 - Damage Areas E & F			
Without	11,823.26	11,823.26	0
Alt. 2A	11,823.26	886.62	10,936.64
Alt. 2Aa	11,823.26	2,082.29	9,740.97

A similar construction cost estimate to the others was prepared for Alternative 2Aa and is displayed below.

Table 2
Construction Cost Estimate – Alternatives 2A & 2Aa

October 2011 Price Level, 4% Interest Rate, 50 Year period of Analysis		
Item	Alt - 2A	Alt - 2Aa
Total Construction Cost	\$9,215,695	\$7,576,284
Contingency	\$2,764,708	\$2,272,885
Design Phase/PED	\$1,382,354	\$1,136,443
Construction Mgt-Inspection & Admin/SI/SA	\$737,256	\$606,103
LERRD Acquisition Costs	\$9,825,000	\$8,351,250
LERRD Investigations cost	\$200,000	\$200,000
Total First Cost	\$24,125,013	\$20,142,964
Interest During Construction	\$984,301	\$821,833
Total Project Economic Cost	\$25,109,313	\$20,964,797
Annualized Project Economic Cost	\$1,168,844	\$975,916
Annual OMRR&R	\$63,071	\$53,610
Total Annual Economic Cost	\$1,231,914	\$1,029,526

The results of the above costs and benefits indicate Alternative 2A produces greater net benefits than Alternative 2Aa.

Table 3
Annual Benefits and Costs

Values are in October 2011 Prices in \$1000s Based on a 50-year Period of Analysis (Discounted using 4 % interest rate)		
Item	Alt 2A	Alt 2Aa
Total Cost	\$25,109	20,965
Annual Benefits Flood Damage Reduction	\$10,937	9,741
Savings in NFIP Administration Costs	\$0	0
Advanced Bridge Replacement	\$13	0
Total Annual Benefits	\$10,950	\$9,741
Annual Costs	\$1,232	\$1,030
Net Benefits	\$9,718	\$8,711
B/C Ratio	8.89	9.46